

CLAIMS

- 1) Machine for treating products with microwaves, particularly for sterilizing solid hospital waste which is usually stowed in suitable cardboard or corrugated plastic boxes, or other products having similar requirements, characterized in that it comprises a plurality of robust containers (1) of any suitable shape and capacity, open at one end at least and suitably pressure- and heat-resistant, which, by the action of a carousel (7) with a vertical axis or any other suitable conveyor means, are cyclically made to interact with at least the following operating stations: a first station which shreds the boxes with the waste, to create a finely shredded product (V) which, by suitable means, is fed and compacted in predetermined constant amounts, suitably moistened, into each container (1); a second station where the mouth of the container, with the compacted, constant and moistened mass of waste inside, is temporarily sealed by suitable means (39) which communicate by means of a wave guide (155) with a source (55) which generates the microwaves with the necessary power and for the necessary amount of time to sterilize the said moist mass of waste (V), this station being equipped at least with means for monitoring and controlling the pressure generated in the container during the microwave heating and with means for depressurizing the container at the end of the cycle; and a final station which discharges the sterilized waste from the container.
- 2) Machine according to Claim 1, in which a third station for dehydrating or drying the sterilized waste to a sufficient degree is provided between the second and final stations.
- 3) Machine according to Claim 1, in which means for cleaning the treatment containers (1) can be provided in the final operating station or after this station.
- 4) Machine according to Claim 1, in which means can be provided for sanitizing the treatment container (1) and if necessary all parts of the machine which operate in contact with the waste to be sterilized, before the said parts are subjected to maintenance operations.
- 5) Machine according to Claim 1, in which the treatment containers (1) can be provided with an outer jacket for thermal insulation (2).

6) Machine according to Claim 1, in which each treatment container (1) carries at least one temperature probe (3) with a corresponding external outlet (103) for removable, rapid and temporary connection to the means which detect the temperature inside the said container during the step of sterilizing the waste contained in it, this probe being preferably positioned as closely as possible to the base of the said container.

7) Machine according to Claim 1, in which each treatment container (1) consists of a steel cylinder of suitable dimensions, with a round cross section, having a suitable inner flare (101) on its upper mouth and a suitable rounding of the angular region of the connection between the side surface and the base of the said container.

8) Machine according to Claim 1, in which the treatment containers (1) are mounted vertically and with their mouths upwards on a carousel with a vertical axis (7), with the possibility of sliding between vertical guides (9, 109) fixed on this carousel, and each of the said containers is provided externally on its base with an axial shank (201) which has a key (4) passing through the shaped through hole (8, 108) in the platform (107) of the carousel, below which the said shank (201) projects with a lower aperture (5) in the shape of a letter C rotated through ninety degrees, and which is kept by the presence of the said key on a theoretical plane containing the axis of rotation of the carousel, in such a way that this aperture can be engaged and disengaged correctly by the head of opposing and/or moving means in the shape of a mushroom or a T, ~~located in the operating stations of the machine.~~

9) Machine according to Claim 1, in which the first operating station comprises:

- Means (10-18) for feeding the boxes with the waste (B), one at a time, into the loading hopper (16) of a shredder (23, 123), with a presser (19) which progressively and in a controlled way pushes the said box towards the shredding means;
- Screening means (25) which allow only the waste shredded to a sufficiently fine and predetermined particle size to pass downwards;
- Conveyor means (26) which collect the shredded waste leaving the said screening means and carry it to a position above the container (1) to be filled;
- Means (27, 127) which collect and drain the excess liquid from the shredded

waste;

- Means (33) for correctly moistening the shredded waste to be inserted and/or already inserted into the treatment container (1);
- A vertical sleeve (29) whose lower end is inserted temporarily by any suitable means for a precise distance into the mouth of the treatment container (1) which is stationary in the loading station, and which is provided with a lateral aperture (32) through which passes the shredded waste arriving from the said conveyor means (26);
- A piston (34) mounted on a vertical slider (230) driven, for example, by a motor (35) with electronic speed, torque and phase control, which cyclically makes the said piston travel along the said guide and compress the shredded waste placed in the treatment container;
- Means for cyclically loading a quantity of shredded waste into the treatment container (1), with values of height and density which are as far as possible constant and predetermined, and means for ensuring that this load of waste contains a sufficient quantity of water.

10) Machine according to Claim 9, in which suitable means (216) can be provided to keep the whole environment in which the waste is shredded at a precise negative pressure with respect to the external environment, and to remove and recover in a safe and hygienic way any dust resulting from the said step of shredding the waste.

11) Machine according to Claim 1, in which the station for sterilizing the load of ~~shredded waste placed in the treatment containers (1) comprises:~~

Means (36, 37) for temporarily raising the container (1) with the waste to be treated in such way that a fixed piston (39) enters the said container with a lateral seal and for a precise distance, this piston having an axial cavity (42) which is connected by a wave guide (155) to the source (55) which produces the microwaves at the frequency and with the power required for the sterilization step;

- In the lower part of the said axial cavity of the piston (39), at least two diaphragms (44, 44') of microwave-permeable but not fluid-permeable material, such as quartz, are provided at a precise distance from each other, and the chamber formed between these two diaphragms, delimited by a suitable spacer (45), is designed for

connection through suitable passages (46-48) to a pressure sensor (49) connected to the processor (50) which controls the operation of the system;

- On the lower face of the said piston (39) there opens a pressure outlet (152) which is connected, by means of a channel (52) having at least two branches, to a safety valve or maximum pressure valve (153) and to a pressure sensor (53) connected to the said processor (50), and is connected to at least one discharge solenoid valve (54) which is also controlled by the said processor (50);

- Any necessary means (56) for the temporary and removable connection of the processor (50) to any temperature probe (3, 103) which may be housed in the base of the treatment container (1);

- Means (50) for activating the source of the microwaves (55) and for ensuring that, when the processor (50) detects the attainment of a predetermined temperature, by means of the temperature sensor (3) if present, or when it indirectly detects this value by means of the pressure sensor (53) which senses a corresponding value of the operating pressure, the said source (55) is kept active for a predetermined period which can be in accordance with the data acquired by the said temperature sensor and/or the pressure sensor, while the pressure within the container (1) is kept at around the said operating level by the modulated opening of the said solenoid valve (54), provision being made to ensure that, at the end of the cycle of sterilization of the waste placed in the treatment container, the said source of microwaves (55) is switched-off, the said solenoid valve (54) is opened to discharge the residual pressure, and finally the said container (1) is removed from the piston (39) located above and is opened, provision being made to ensure that, during the active stage of operation of the station in question, if the pressure in the container (1) exceeds predetermined safety levels, the said safety valve (153) is triggered, and that, if the safety sensor (49) detects a pressure in excess of zero, the sterilization unit is automatically depressurized and opened, and an alarm signal is generated to warn of the occurrence of the problem, which is probably caused by the breaking of the seal (43) of the lower quartz piece (44) or by the breaking of this quartz piece.

12) Machine according to Claim 2, in which the station, if any, operating after the

sterilization station and responsible for drying or dehydrating the sterilized waste in the treatment container (1) comprises a piston (58) with corresponding external seals (158) and comprises means (62) for inserting this piston into the mouth of the said container and vacuum means (61) are connected to the said piston and to its channels for internal connection to the container, for sucking from the latter the excess liquid contained in the sterilized waste.

13) Machine according to Claim 12, in which, in order to improve the operation of the said station for drying the treated waste, each treatment container (1) can be provided in its base with at least one one-way valve which opens automatically to allow the passage of ambient air only when the said container is connected to the said vacuum source (61).

14) Machine according to Claim 1, in which the final station for discharging the sterilized waste from the treatment container (1) comprises:

- Means (63-69) for raising the container (1) with the waste from the corresponding lateral guides (9, 109) with the coupling of anti-rotation means (164, 264) with corresponding recessed parts (6, 106) provided in the shank (201) of the said container, these raising means being associated with and opposed to an annular hopper (73) which by reaction to the raising of the container (1) and in opposition to the action of elastic means (75) is inserted into the mouth of the container to protect it from contamination and to form an externally enlarged and diverging extension of the said mouth, the said raising means being provided with means (70, 71) for making the container (1) rotate into a substantially horizontal position during the final part of the said raising;
- Means, of a screw type for example (76-79), for extracting the treated waste from the container (1) in a substantially horizontal position, in such a way that the waste falls on to means of collection and evacuation;
- Means for returning the emptied container (1), between the corresponding vertical guides (9, 109) of the carousel, until it rests on the platform (107) of the said carousel, with the original angular orientation, while the assembly with the hopper (73) interacts with fixed means (268) which stop its downward travel in such a way that the

said hopper is disengaged from the container (1) and is suitably removed from it, to allow the free transfer of the container by the carousel (7) to the next operating station.

15) Machine according to Claim 14, in which means can be provided in the final operating station or after this station, to clean the treatment containers internally and if necessary to test the operation of the temperature probes, if present (3, 103).

16) Machine according to Claim 9, in which the sleeve (29) and the hopper (73), which are inserted into the mouth of the treatment container (1) during the loading and discharge of the waste into and from the said container, have such shapes and dimensions and are made from such materials that the whole of the upper inner part of the said container (1) designed to interact with the piston (39) of the waste sterilization station is kept clean.

17) Machine according to Claim 8, characterized by the use of a transfer, with horizontal axes for example, in place of the carousel with the vertical axis (7), for cyclically transferring the treatment containers (1) to the successive operating stations, means being provided to retain the said containers in the corresponding guides (9, 109) during the stage of running around the sprockets of the transfer and during travel along the lower branch of the said transfer, means of discharging the shredded waste and means, if any, of cleaning the said containers being made to operate during the stage in which the containers are positioned horizontally and orientated downwards.

18) Process for treating products with microwaves, particularly for sterilizing solid hospital waste, usually stored in suitable boxes (B), characterized by the succession of the following operating steps:

- Fine shredding of the boxes with the waste and moistening with water, to precise levels, of the shredded product (V) obtained in this step;
- Insertion of a precise quantity of shredded and moistened waste into treatment containers (1) open at one end at least, and compaction of this waste, in such a way that the load of waste has characteristics of height, density and moisture content which are as far as possible constant and predetermined;
- Closing the said treatment container (1) to form a seal, and connecting the container to a source (55) which generates microwaves at approximately 2.45 GHz for

example and with suitable power, to raise the temperature of the waste and water within the said container to precise levels and to maintain this temperature for a time sufficient to ensure the sterilization of the said waste, while the internal pressure of the container is regulated by a controlled discharge towards the exterior, in such a way that predetermined maximum values are not exceeded, the treatment container with the sterilized waste being made to be depressurized and reopened at the end of the cycle;

- Discharge of the sterilized waste from the treatment containers, cleaning of the said containers (1) if necessary, and reintroduction of the containers into the operating cycle.

19) Process according to Claim 18, in which the sterilization step includes keeping the shredded and moistened waste at a temperature of approximately 150°C for a period of approximately 9-10 seconds at least, while the pressure within the treatment containers is kept below a specified maximum level, for example below 8 bars.